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(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
22 November 2001 (22.11.2001)

PCT

(10) International Publication Number
WO 01/89031 A1

(51) International Patent Classification[7]: H01Q 1/24, 1/38

(21) International Application Number: PCT/SE01/01078

(22) International Filing Date: 15 May 2001 (15.05.2001)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
0001811-9 15 May 2000 (15.05.2000) SE
60/204,325 15 May 2000 (15.05.2000) US

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(81) Designated States *(national)*: AE, AG, AL, AM, AT, AT (utility model), AU, AZ, BA, BB, BG, BR, BY, BZ, CA, CH, CN, CO, CR, CU, CZ, CZ (utility model), DE, DE (utility model), DK, DK (utility model), DM, DZ, EC, EE, EE (utility model), ES, FI, FI (utility model), GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, MZ, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, SK (utility model), SL, TJ, TM, TR, TT, TZ, UA, UG, US, UZ, VN, YU, ZA, ZW.

(84) Designated States *(regional)*: ARIPO patent (GH, GM, KE, LS, MW, MZ, SD, SL, SZ, TZ, UG, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE, TR), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GW, ML, MR, NE, SN, TD, TG).

Published:
— *with international search report*

For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

WO 01/89031 A1

(54) Title: ANTENNA ARRANGEMENT

(57) Abstract: The invention refers to an antenna arrangement (10) of the type that comprises an antenna element (11) arranged spaced apart from a ground plane (12) and provided with at least one feeding connector element (13) and at least one ground connector element (14, 14'). The ground plane (12) is arranged with a specific length and/or pattern so that it is tuned and arranged as at least a part of a matching circuit.

TITLE

ANTENNA ARRANGEMENT

TECHNICAL FIELD OF THE INVENTION

The present invention relates to an antenna arrangement of the type that comprises a ground plane spaced apart from an antenna plane for use in a mobile communication device.

Especially the invention concerns the ground plane dependent antennas. The invention also concerns a communication device including such an antenna.

BACKGROUND OF THE INVENTION

The wireless forms of communications have become a standard way of communication. There are many types of means for conducting a wireless communication, such as cordless telephones, lap top computers with wireless modems, satellite and cellular telephones. The communication device, i.e. the mobile handsets rapidly become smaller and lighter and the globalisation demand, multiple communication functions and standards being combined into a single unit, e.g. for communicates in multiple frequency bands. There are a variety of different radiotelephone systems in use today. These include different analogue or digital CDMA (Code Division Multiple Access) and TDMA (Time Division Multiple Access) based systems like GSM (Global System for Mobile telecommunication), AMPS (Advanced Mobile Phone System), DAMPS(Digital Advanced Mobile Phone System), PCS (Personal Communication Services), DCS (Digital Communication System), PCN (Personal Communication Networks), PDC 800 and 1500 and different cordless telephone systems.

Different systems operate in different frequency bands, thus requiring different antennas for maximum efficiency.

Over the past years, since the first PIFA (Planar Inverted-F Antenna) was disclosed, there have been several types of microstrip antennas with both a feed and a ground connection. Several methods of unique feeding or loading arrangements of the antenna (or combinations of both) have been disclosed.

In order to reduce the size of a microstrip antenna, the antenna requires a load, either capacitive or inductive. An inductive load consists of slots within the antenna and a capacitive load is formed by either a dielectric material placed at certain locations or bringing the metal closer to the ground plane. Both methods of forming a capacitive load require three-dimensional structures.

To address multiple frequency bands, there are several know methods. A parasitic (or galvanic coupled) element may be placed above the antenna, where this parasitic element would have a resonance at a higher frequency band. This layered construction of the antenna requires more complex mass-production techniques than single layer microstrip antennas.

Alternatively, the antenna may consist of several elements parallel to each other. Although the antenna consists of only one layer, the parallel elements have a strong coupling, making it difficult to tune each element separately.

Moreover, the antenna designers invest a great deal of time for designing the half of the antenna, i.e. the radiator part, while the second half, i.e. ground plane, has not been changed remarkably in past years.

In the European Patent Application No. 892 459 – A1, an antenna arrangement is disclosed having a ground plane, which in one embodiment can be is provided with a notch. Changing the size of the notch changes the radiation characteristics.

SUMMARY OF THE INVENTION

The main object of the present invention is to provide an antenna of ground plane

dependent type, which through a new tuned ground plane structure, provides enhanced antenna characteristics. Other object of the invention is to provide a ground plane that can be a part of the matching component in a communications device.

Therefore the ground plane in the initially mentioned antenna arrangement is arranged with a
specific length and/or pattern so that it is tuneable and arranged as at least a part of a matching circuit. The ground plane is provided with at least one non-conductive space arranged as a capacitive and/or inductive load, that the capacitive load in from of said non-conductive space is arranged in a distance from said connector element and that said inductive load in from of said non-conductive space is arranged close to said connector element.

Preferably, said ground plane has an electrical length, electrically sufficient for good performance of antenna. Most preferably, said electrical length is $\geq 1/4\ \lambda$, wherein λ is the antenna's operation wavelength. In one embodiment, the ground plane is provided with at least one non-conductive space arranged as a capacitive and/or inductive load. In one embodiment said ground plane is arranged through etching on a circuit board. A capacitive load in from of a non-conductive space is arranged in a distance from the connector elements. An inductive load in from of a non-conductive space is arranged close to the connector elements.

According to a method of tuning an antenna arrangement comprising an antenna element arranged spaced apart from a ground plane and provided with at least one feeding connector element and at least one ground connector element. The method is accomplished by arranging said ground plane with a specific length and/or pattern so that it is tuned and arranged as at least a part of a matching circuit.

The invention also concerns a communication arrangement comprising an internally arranged antenna device, comprising an antenna element arranged spaced apart from a ground plane and provided with at least one feeding connector element and at least one ground connector element. The ground plane is provided with a specific length and/or

pattern so that it is tuned and arranged as at least a part of a matching circuit. The communication arrangement may be a cellular phone or a Bluetooth-based device.

BRIEF DESCRIPTION OF THE DRAWINGS

In the following, the invention will be further described in a non-limiting way under reference to the accompanying drawings in which:

Fig. 1 is a schematic top view of a preferred embodiment of an antenna according to the present invention,

Fig. 2 is a cross-section along line A-A in fig. 1,

Fig. 3 shows a magnified view of the encircled section in fig. 2,

Fig. 4 is a cross-section along line B-B in fig. 1, illustrating a first embodiment, and

Fig. 5 shows a magnified view of the encircled section in fig. 4.

DETAILED DESCRIPTION OF THE EMBODIMENTS

The main features of the present invention include changing the characteristics of the ground plane, among others through altering its electrical length (with respect to the antenna element) and/or arranging inductive or capacitive loads.

Referring to figs. 1-5, reference sign 10 denotes an antenna arrangement, comprising an antenna element 11, a ground plane 12, connector elements 13 and 14, and a spacer 15.

The antenna element 11 is a dual or multi band antenna consisting of a conductive sheet provided with a substantially longitudinal and vertical slit 16 or non-conductive space. However, slits 16, if arranged, may have other shape and location on the antenna element. In case of a single band antenna the slit 16 can be eliminated.

The connector element 13 is arranged as a substantially S-shaped clip or clasp (figs. 2 and 3). Clearly, the shape of the clip is not limited to S-shape and can be varied. The connector element 13 is arranged to connect the antenna element 11 to a feed point 17

on a PCB 18. The connector element 14 is arranged to connect the ground plane 12 and antenna element 11. The feed and grounding points can be connected to the sender/receiver circuitry (not shown) of the communication device.

The connector clip 13 (figs. 2-3) comprises a first end 21 connecting to the antenna element 11. The clip, as mentioned above is substantially S-shaped, having a first section 131 (fig. 3) and a second section 132. The first section 131 comprises two substantially parallel portions 133 and 134, also substantially parallel to the antenna element 11 and ground plane 12. The distance between said first and second portions corresponds to the spacer 15. The second portion is substantially "nose"-shaped having an inclining section 135, which ends in a connector end 136. The portion 133 is arranged with a bulging 137. The clip is connected to the antenna element 11, at the end section 21 through an extension 139, which extends inside a groove on the antenna element. The end 21 can be fixed in place by means of a rivet, a weld, conductive adhesive, etc. By prearranging the grooves on the antenna element 11, it is possible to obtain a distinct distance between the ends 21 and 22 of the clips, which affects the antenna characteristics.

As it is evident from fig. 1, the ground plane 12 can be longer than the antenna element 11, which gives it a longer electrical length. It is important that the antenna has an electrical length, electrically sufficient for good performance, preferably it can be $\geq 1/4\ \lambda$, wherein λ is the antenna's operation wavelength. Moreover, it is at one end arranged with slits 121 and 122, which form the capacitive and inductive loads. The length of the ground plane, the number of slits, their shape and position can vary with respect to the desired antenna characteristics. A good capacitive characteristic is obtained if the capacitive load is placed distanced from the feeding points (21, 22) and a good inductive load is obtained if the inductive load is placed close to the feeding points. Moreover, the capacitive load can be modified by bending at least part of the ground plane with respect to the antenna element. Thus, the characteristics of the loads of the ground plane affect the characteristics of the entire antenna. In the described embodiment, the ground plane is a part of antenna separate from the PCB. However, it can be arranged as a part of the PCB, e.g. through etching a specific pattern on one side of the PCB. Thus, it is

important that the RF ground is adjusted to increase the performance.

The feeding connector clip 13 (fig. 3) is isolated from the ground plane 12 through an opening 20 in the ground plane 12. For this reason, the spacer 15 is provided with an extension 151, on which some part of the section 133 bears against, which distances it from the ground plane 12. It is also possible to isolate the clip 13 from the ground plane 12 in another ways.

In figs. 4 and 5 the connector clip 14 is disclosed in more detail. The clip 14 according to this embodiment is a substantially U-shaped part connecting between the antenna element and the ground plane. Clearly, the shape of the clips is not limited to U-shape and can be varied. The ground plane 12 can be connected to ground, e.g. in case of a PIFA, through a pin 14' shaped as prying from the PCB or other section connecting to the ground plane.

Accordingly, the antenna has a modular structure, comprising of parts which can be manufactured separately and assembled together with regard to the communication device design, frequency requirements etc.; for example, the location of the connector clips can be varied to obtain required antenna features, the form of the antenna element can be varied for obtaining single or multi-band characteristics while same ground plate is used and so on.

The antenna arrangement according to the present invention can be used in any suitable communications device, such as cellular phones, bluetooth devices etc.

The invention is not limited the shown embodiments but can be varied in number of ways without departing from the scope of the appended claims and the arrangement and the method can be implemented in various ways depending on application, functional units, needs and requirements etc.

CLAIMS

1. An antenna arrangement (10) of the type that comprises an antenna element (11) arranged spaced apart from a ground plane (12) and provided with at least one feeding connector element (13), said ground plane (12) being arranged with a specific length and/or pattern so that it is tuned and arranged as at least a part of a matching circuit. *characterized in*
that said ground plane is provided with at least one non-conductive space (121, 122) arranged as a capacitive and/or inductive load, that the capacitive load in from of said non-conductive space (122) is arranged in a distance from said connector element and that said inductive load in from of said non-conductive space (121) is arranged close to said connector element.

2. The arrangement of claim 1,
characterized in
that said ground plane has an electrical length, electrically sufficient for good performance of antenna

3. The arrangement of claim 2,
characterized in
that said electrical length can be $\geq 1/4\ \lambda$, wherein λ is the antenna's operation wavelength.

4. The arrangement according to any of preceding claims,
characterized in,
that said ground plane is arranged through etching on a circuit board.

5. A method of tuning an antenna arrangement comprising an antenna element (11) arranged spaced apart from a ground plane (12) and provided with at least one feeding connector element (13), said ground plane (12) being arranged with a specific length and/or pattern so that it is tuned and arranged as at least a part of a matching circuit, *characterized by*

providing said ground plane with at least one non-conductive space (121, 122) arranged as a capacitive and/or inductive load, arranging said capacitive load in from of said non-conductive space (122) in a distance from said connector element and arranging said inductive load in from of said non-conductive space (121) close to said connector element.

6. A communication arrangement comprising an internally arranged antenna device (10), comprising an antenna element (11) arranged spaced apart from a ground plane (12) and provided with at least one feeding connector element (13), said ground plane (12) being provided with a specific length and/or pattern so that it is tuned and arranged as at least a part of a matching circuit in said communication arrangement,
characterized in
that said ground plane is provided with at least one non-conductive space (121, 122) arranged as a capacitive and/or inductive load, that the capacitive load in from of said non-conductive space (122) is arranged in a distance from said connector element and that said inductive load in from of said non-conductive space (121) is arranged close to said connector element.

7. The communication arrangement of claim 6,
characterized in,
that said communication arrangement is a cellular phone.

8. The communication arrangement of claim 6,
characterized in,
that said communication arrangement is a Bluetooth device.

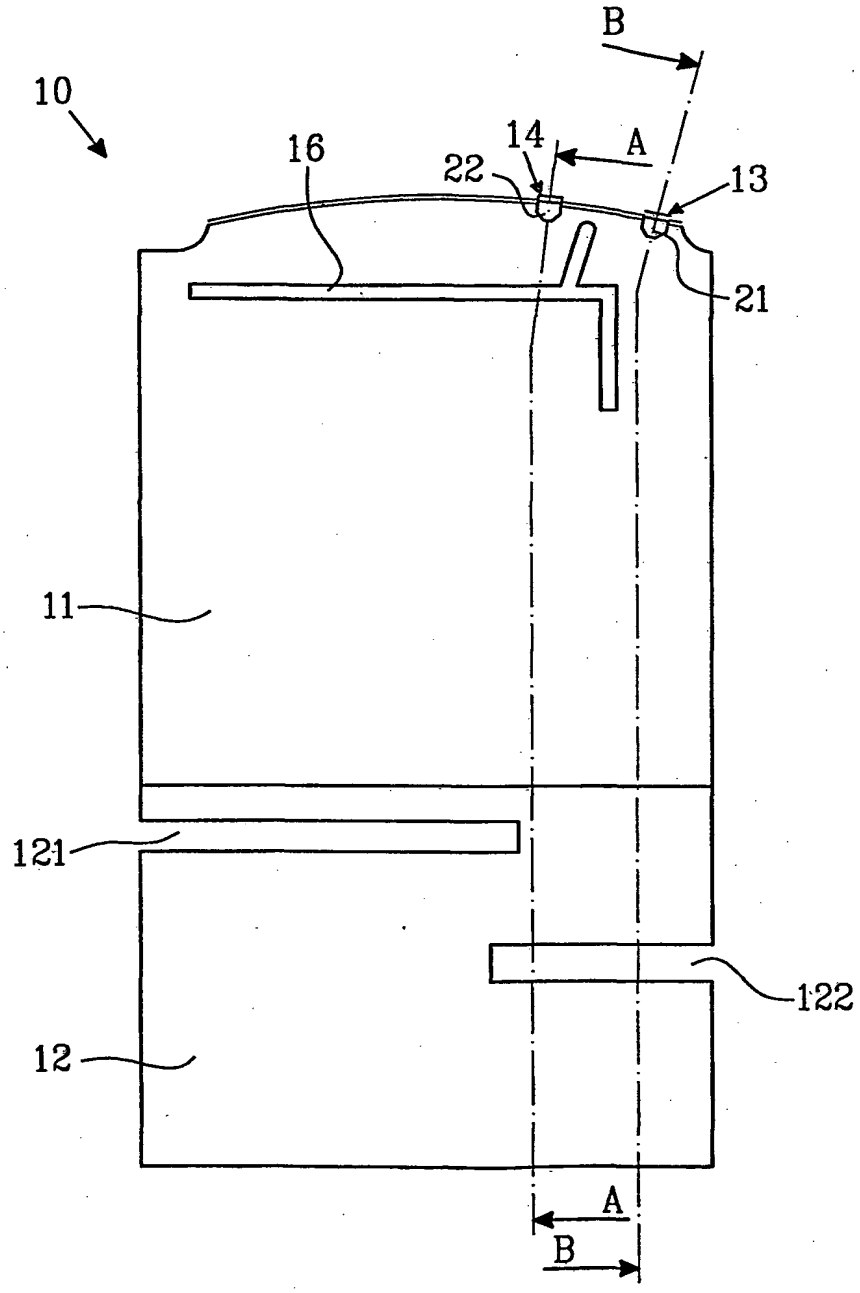

FIG.1

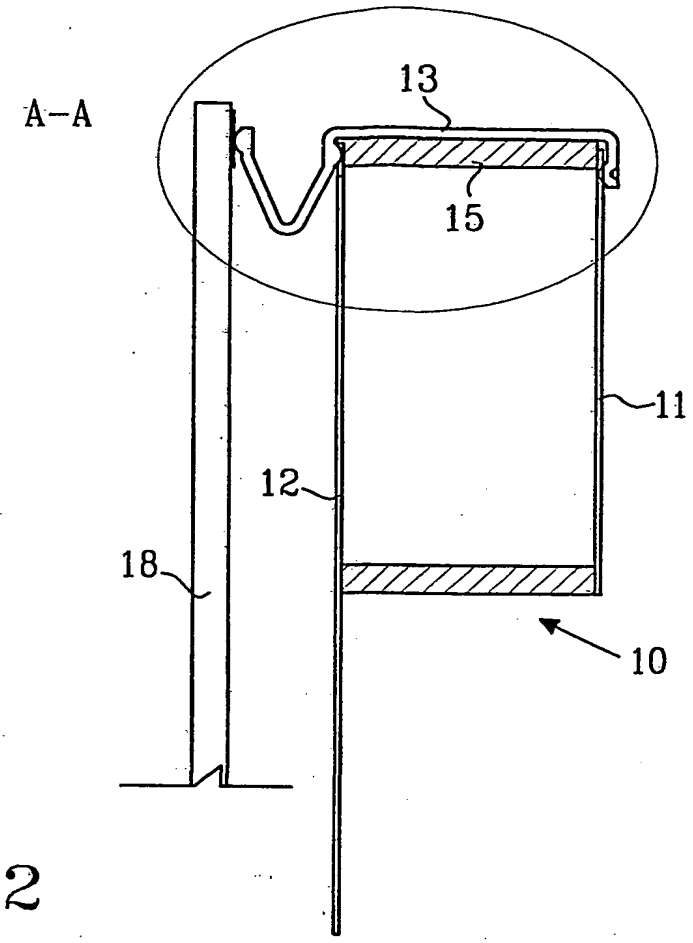

FIG.2

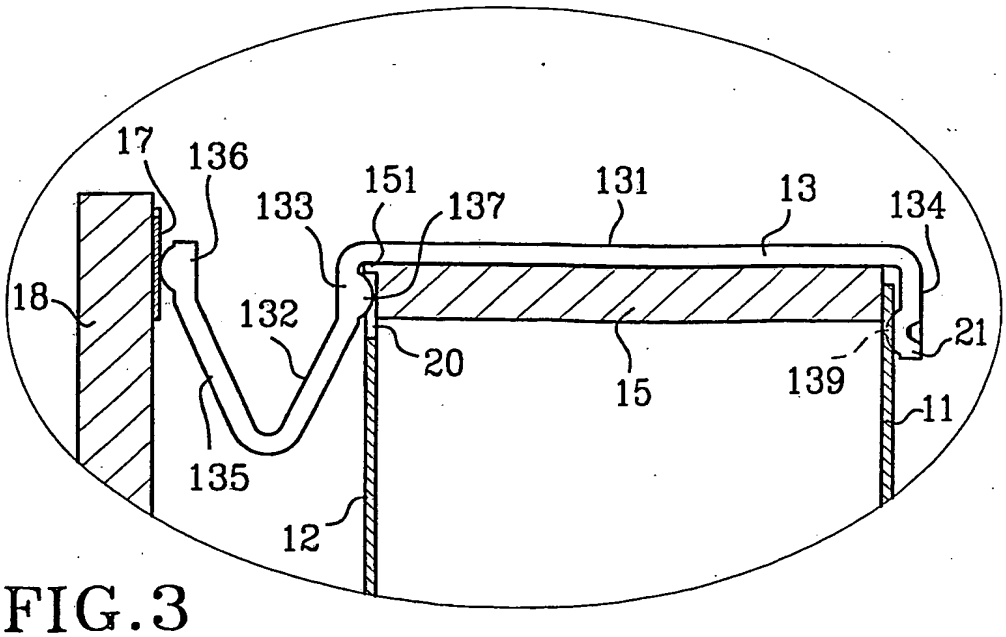

FIG.3

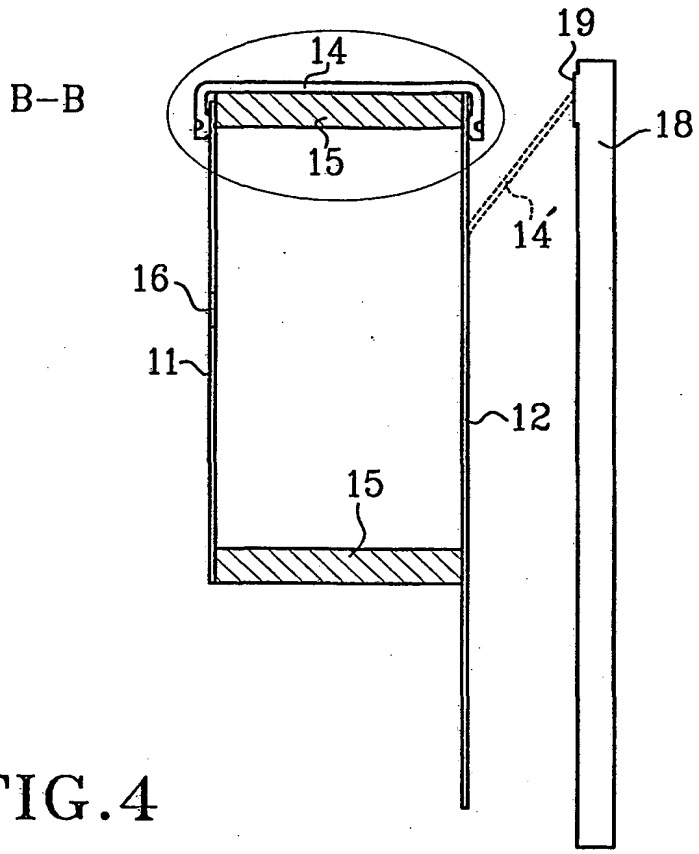

FIG.4

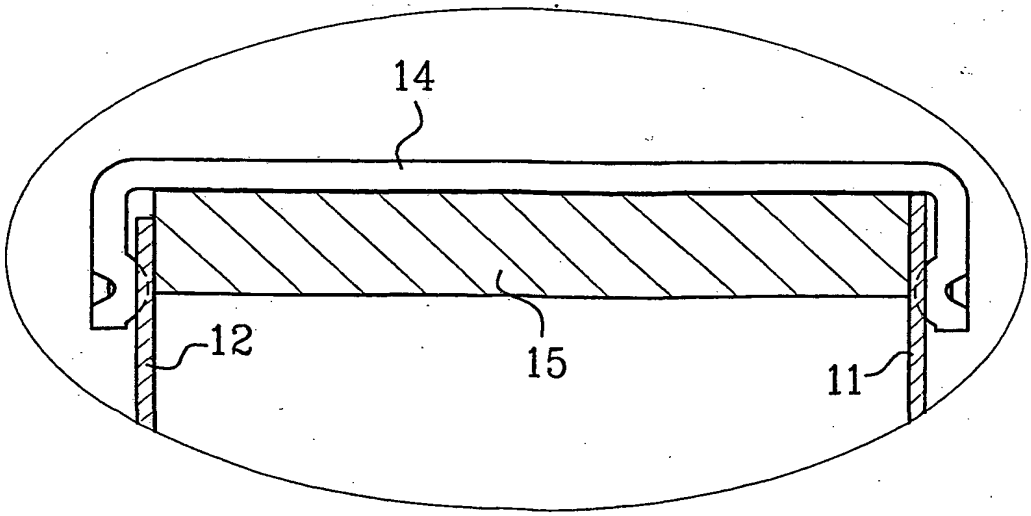

FIG.5

INTERNATIONAL SEARCH REPORT

International application No.
PCT/SE 01/01078

A. CLASSIFICATION OF SUBJECT MATTER

IPC7: H01Q 1/24, H01Q 1/38
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC7: H01Q

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

SE,DK,FI,NO classes as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

EPO-INTERNAL, WPI DATA

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	EP 0892459 A1 (NOKIA MOBILE PHONES LTD.), 20 January 1999 (20.01.99), column 10, line 9 - line 55, figure 12 --	1-8
A	US 5262792 A (Y. EGASHIRA), 16 November 1993 (16.11.93), column 5, line 1 - line 18 --	1-8
A	US 5764190 A (R.D. MURCH ET AL.), 9 June 1998 (09.06.98), column 5, line 32 - line 38, figure 14, abstract --	1-8

[X] Further documents are listed in the continuation of Box C. [X] See patent family annex.

* Special categories of cited documents:
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"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"X" document of particular relevance: the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance: the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
9 July 2001	17 -07- 2001
Name and mailing address of the ISA/ Swedish Patent Office Box 5055, S-102 42 STOCKHOLM Facsimile No. +46 8 666 02 86	Authorized officer Marianne Dickman/AE Telephone No. +46 8 782 25 00

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ICID: <WO__0189031A1_I_>

INTERNATIONAL SEARCH REPORT

International application No.
PCT/SE 01/01078

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
P,A	EP 1052723 A2 (NOKIA MOBILE PHONES LTD.), 15 November 2000 (15.11.00), figures 3-12, abstract	1-8

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INTERNATIONAL SEARCH REPORT

Information on patent family members

02/07/01

International application No.
PCT/SE 01/01078

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
EP 0892459 A1	20/01/99	FI 972897 A	09/01/99
		FI 981571 A	09/01/99
		US 6140966 A	31/10/00
US 5262792 A	16/11/93	NONE	
US 5764190 A	09/06/98	NONE	
EP 1052723 A2	15/11/00	FI 991068 A	11/11/00

(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

CORRECTED VERSION

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International Bureau

(43) International Publication Date
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PCT

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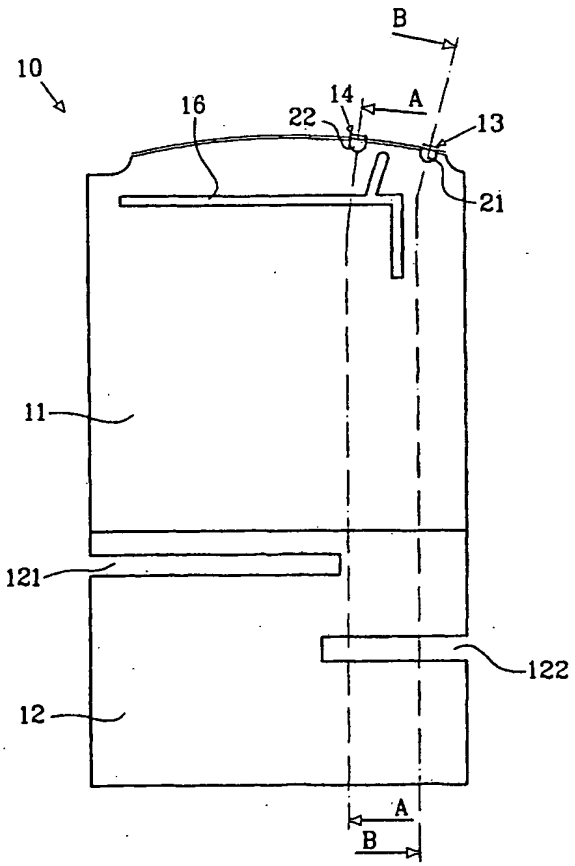

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WO 01/89031 A1

SK, SK (utility model), SL, TJ, TM, TR, TT, TZ, UA, UG, US, UZ, VN, YU, ZA, ZW.

(84) **Designated States** *(regional)*: ARIPO patent (GH, GM, KE, LS, MW, MZ, SD, SL, SZ, TZ, UG, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE, TR), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GW, ML, MR, NE, SN, TD, TG).

Published:
— *with international search report*

(48) **Date of publication of this corrected version:**
28 February 2002

(15) **Information about Correction:**
see PCT Gazette No. 09/2002 of 28 February 2002, Section II

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